A PARALLEL ALGORITHM FOR THE NONLINEAR DYNAMIC ANALYSIS OF STRUCTURES

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Dynamic loads such as earthquakes and blast loading can produce dramatic and tragic effects on society by causing loss of lives, property damage, and societal disruption. Response to these types of loads can be found in a number of ways. The most versatile and informative method to accomplish this consists of directly integrating the equations of motion arising from a finite element analysis. In general, such a transient finite element analysis of real structures is computationally intensive, especially when nonlinearities are present. Parallel processing provides an excellent venue for achieving the additional computational power necessary to successfully perform these simulations**.**

Several concurrent algorithms have been developed for transient analysis of structures in the past fifteen years. Amongst these methods, the Iterative Group Implicit (IGI) algorithm has been considered as one of the most promising methods that take advantage of parallel computing architectures. In this method, the solution is found on a subdomain-by-subdomain basis and compatibility and equilibrium at the interface degrees of freedom is restored by means of an iterative procedure. The IGI algorithm has been implemented and tested for linear structural dynamics applications. It has been found that this algorithm provides accurate and reliable solutions. Furthermore, the performance of the method in distributed computing environments has been found to be excellent producing near linear speed-ups in large applications.

Nonlinear implicit transient analysis of structures is an even more challenging computational task than its linear counterpart. This is because nonlinear schemes require frequent updating of the structural stiffness matrix and of the solution of linear systems of algebraic equations. Consequently, the utilization of a low cost distributed network or a dedicated parallel machine becomes highly desirable, especially for structures with numerous degrees of freedom, such as three-dimensional structural systems. In the present work, the IGI algorithm is extended for nonlinear applications. For nonlinear case, while IGI iterates to find compatible and equilibrating interface forces between the subdomains, a global nonlinear iteration will also be performed. The integration of these two iterations is being investigated. These iterations may be combined and performed in a single process loop or they may need to be isolated. Convergence studies will be carried out to select the iteration scheme with the best performance.

The developed nonlinear iterative method will be investigated via numerical studies. Both material and geometric nonlinearities will be considered. A three-dimensional framed structural application will be developed to demonstrate the performance and accuracy of the method. The transient nonlinear analysis of the frame will be carried out for an existing earthquake motion record. This application will be tested on both a network of SUN workstations and on the IBM SP2 distributed computer. It is expected that the developed method will produce significant speed-ups when compared to the sequential version.